ORIGINAL RESEARCH

Effectiveness of Mobile Health Platform-Based Continuity of Care in Osteoporosis Prevention and Treatment

Wei-Ping Cheng, MBBS; Li Sun, MBBS; Dan Shen, MBBS; Guan-Hua Xu, PhD; Jia-Wei Jiang, MM; Hai-Yan Gu, MBBS

ABSTRACT

Objective • To assess the effectiveness of using mobile health platforms for continuous care in preventing and treating osteoporosis.

Methods • 114 patients with osteoporosis admitted to Nantong First People's Hospital from March 2021 to June 2022 were recruited and assigned equally via random number table method to receive either routine care (namely education on osteoporosis disease, dietary guidance, exercise guidance, activity guidance, medication supervision, fall prevention, psychological care, and secondary health education at the time of discharge) (routine group) or mobile health platform-based continuity of care (continuity group), with 57 patients in each group. Outcome measures included treatment compliance, disease knowledge of osteoporosis (diet, exercise, risk factors), quality of life level, and care satisfaction.

Results • All eligible patients were followed up for one year after discharge from the hospital. Patients with continuity of care showed higher treatment compliance and disease knowledge of diet, exercise, and risk factors than those with routine care (P = .004). Continuity of care

Wei-Ping Cheng, MBBS; Li Sun, MBBS; Dan Shen, MBBS; Guan-Hua Xu, PhD; Jia-Wei Jiang, MM; Nantong first people's Hospital of Jiangsu Province Spinal surgery; Hai-Yan Gu, MBBS; Nantong first people's Hospital of Jiangsu Province Nursing Department.

Corresponding author: Hai-Yan Gu, MBBS E-mail: guhszml1585@163.com

INTRODUCTION

Osteoporosis is a common clinical systemic skeletal disease that manifests clinically as a decrease in bone mass, bone strength, bone density, and destruction of bone tissue microstructure, resulting in an extremely high predisposition to fracture and bone pain, which seriously compromises the quality of life of patients.¹ Osteoporosis affects a substantial portion of the population, particularly older adults, and its prevalence is increasing worldwide. In China, it is recognized

was associated with significantly higher MOS 36-item short-form health survey (SF-36) scores (The SF-36 is a self-administered questionnaire containing 36 items that survey overall health status) and nursing satisfaction in patients versus routine care (P = .004).

Conclusion • Mobile health platform-based continuity of care effectively enhances post-discharge compliance and knowledge of osteoporosis in patients with osteoporosis, thereby improving post-discharge quality of life and satisfaction with care. Multi-center studies involving diverse healthcare settings and patient populations would provide more robust evidence. Moreover, these findings highlight the potential benefits of incorporating mobile health platforms into the care continuum for osteoporosis patients. Also, by utilizing mobile health platforms, healthcare providers can extend their reach beyond hospital settings and provide continuous care and support to patients, potentially reducing the burden on healthcare systems and improving overall population health outcomes. (*Altern Ther Health Med.* 2024;30(12):144-149).

as a major public health hazard. According to epidemiological studies, the prevalence of osteoporosis among Chinese individuals aged 50 years and above is estimated to be around 26.9%, with higher rates among women compared to men. The aging population and changes in lifestyle factors contribute to the rising incidence of osteoporosis, making it a significant health concern.² The management of osteoporosis is a lengthy process where long-term medication and rehabilitation exercises are required after discharge.³ However, due to the older age of osteoporosis patients and their lack of disease awareness, patients with osteoporosis usually show poor compliance with post-discharge treatment, which ultimately undermines the treatment outcome.4 Postdischarge care plays a critical role in the management of osteoporosis. After being discharged from the hospital, patients with osteoporosis require long-term medication and rehabilitation exercises to prevent further bone loss and

reduce the risk of fractures. However, due to factors such as advanced age and inadequate disease awareness, patients often exhibit poor compliance with post-discharge treatment recommendations.⁴ This lack of adherence undermines the effectiveness of treatment and hinders the overall outcome.

Recognizing the importance of post-discharge care, the implementation of interventions to support patients with osteoporosis after hospital discharge becomes crucial. Providing continuity of care and appropriate nursing interventions can significantly improve treatment outcomes and enhance patients' quality of life. Ensuring that patients receive ongoing education, guidance, and support beyond hospitalization is vital for optimizing their health and reducing the risk of readmission.

Continuing care is an emerging clinical care model that is highly appropriate for osteoporosis, a disease with a long recovery cycle.⁵ The implementation of continuity of care in patients with osteoporosis after discharge is of great significance in improving the utilization of medical resources, reducing the risk of readmission, and improving the quality of life of patients.⁶ Mobile health platform-based continuity of care is a web-based multimedia health education model that provides rapid health education to patients through videos, pictures, and text.⁷ Mobile health platform education features the benefits of convenience, affordability, and wide accessibility, and it effectively improves patient adherence to treatment after discharge.⁸

Currently, relatively little knowledge is available related to the application of mobile health platform-based continuity of care to patients with osteoporosis. To this end, the present study was conducted to evaluate the effectiveness of mobile health platform-based continuity of care in the prevention and treatment of osteoporosis.

MATERIALS AND METHODS Participants

114 patients with osteoporosis admitted to Nantong First People's Hospital from March 2021 to June 2022 were recruited and assigned equally via the random number table method to receive either routine care (routine group) or mobile health platform-based continuity of care (continuity group), with 57 patients in each group. The study was approved by the ethics committee of our hospital.

Randomization

Randomization through a random number table involves assigning participants to different groups based on a sequence of random numbers. This method ensures that each participant has an equal chance of being assigned to either the routine care group or the mobile health platform-based continuity of care group. By using a random number table, the assignment process is free from human bias and ensures the groups are balanced in terms of potential confounding factors.

Ethical Considerations

Before the commencement of the study, all participants were provided with comprehensive information regarding

the nature, purpose, and potential implications of their involvement, ensuring they were fully aware of the study's objectives and procedures.

Respecting the confidentiality and privacy of participants' data was of utmost importance. All collected data, including personal and health-related information, were treated with strict confidentiality. To safeguard participant privacy, data were anonymized and stored securely, with restricted access limited to the research team.

The study received formal approval from the institutional review board (IRB) of our hospital, ensuring compliance with ethical guidelines and research protocols.

Inclusion and exclusion criteria

Inclusion criteria: 1) patients were diagnosed with osteoporosis by relevant clinical test results (dual-energy X-ray absorptiometry (DXA), quantitative ultrasound (QUS), laboratory tests, spine X-rays, or computed tomography (CT) or magnetic resonance imaging (MRI)); 2) aged ≥ 60 years; 3) with mental clarity and normal communication skills at admission; 4) with smartphones and basic operations; 5) patients and family members were informed and voluntarily signed consent forms for the study.

Exclusion criteria: 1) with psychiatric disorders or dementia; 2) with prolonged bed rest; 3) without family companionship; 4) with severe organ function disorders; 5) patients and family members who were unable to cooperate completely with this study.

Treatment methods

(1) Patients in the routine group received routine care. Routine care included education on osteoporosis disease, dietary guidance, exercise guidance, activity guidance, medication supervision, fall prevention, psychological care, and secondary health education at the time of discharge. Regular telephone follow-ups were conducted after discharge from the hospital. The total follow-up period was 1 year, and the frequency of follow-up visits was once every 2 weeks for the first 3 months and adjusted to once every 4 weeks after 3 months.

(2) Patients in the continuity group received routine care and mobile health platform-based continuity of care. The routine care was identical to that in the routine group. 1. Establishment of a mobile health platform education team. The mobile health platform education team in this study consisted of a nurse manager, a department head, six basic nurses, three orthopedic surgeons, and a rehabilitation physician. Team members regularly sent educational content to patients for guidance and communicated with patients through WeChat groups and QQ groups. All team members were professionally trained before the trial until they were proficient in osteoporosis-related knowledge and health education methods. The health education methods included drug instruction, exercise instruction, rehabilitation exercise instruction, outing activity instruction, diet instruction, and fall prevention instruction. 2. Investigation of the actual nursing needs of patients after discharge. Nursing staff

provided discharge health education and guidance within 1 week before the patient's discharge from the hospital and understood the patient's actual post-discharge care needs, including self-management ability, out-of-hospital living habits, and disease-related knowledge mastery after discharge. 3. Specific measures: WeChat or QQ group chat was created, and relevant educational content was provided to the patients and their families through group chat every Wednesday and Saturday from 14:00 to 16:00. The content of education includes 1) Medication guidance: All patients were allowed to consult their health care providers at any time about their medications, such as dosage and frequency. For older patients, corresponding team members were assigned to remind and supervise their medications regularly;⁹ 2) Exercise guidance: The team members guided the patients to perform exercises and advised them on safety precautions during the exercises; 3) Rehabilitation exercise guidance: Patients were instructed by the rehabilitators to perform active or passive exercises to prevent osteoporosis-related complications. The rehabilitators supervised the patients to perform regular exercises such as grip strength exercises and slow walking exercises to increase the patients' muscle strength;¹⁰ 4) Outdoor activities guidance: Patients were instructed to perform regular activities to enhance their bone strength. 5) Dietary guidance: Group members provided patients and their families with dietary knowledge and related precautions and instructed patients on the amount of daily calcium intake;¹¹ 6) Fall prevention guidance: Falls are an important risk factor for patients with osteoporosis. In the elderly population, the annual fall rate is approximately 32%, and more than 50% of the population will experience multiple falls. The patients were graded for fall risk to allow for the implementation of targeted instruction and nursing interventions. Team members recommended assistive aids to patients with poor lower limb strength and a high risk of falls to further reduce the risk of falls;¹² 7) Review guidance: The patients were reminded via group chat to visit the clinic for regular review. In addition, team members were required to hold regular meetings at least once a month to discuss recently identified improper issues and develop appropriate solutions.

Overall, the mobile health platform likely aimed to bridge the gap between hospital-based care and postdischarge management. By providing continuous access to health information, monitoring patients' progress, promoting adherence to treatment plans, and facilitating communication with healthcare providers, the platform aimed to enhance patient engagement, knowledge, and self-management abilities. The interventions in both groups spanned 3 months.

Outcome measures

Compliance: complete compliance: Patients maintained complete compliance with daily dosing and outings; Good compliance: patients were relatively more cooperative in receiving daily medication and participating in outdoor activities, with the number of times of resistance of less than 5; Poor compliance: Patients were relatively uncooperative with daily dosing and outdoor activities, with frequent resistance behaviors. **Knowledge of osteoporosis**: The osteoporosis knowledge questionnaire was used to assess the patients' knowledge of osteoporosis disease at the time of discharge and 1 year after discharge. The osteoporosis knowledge questionnaire consisted of 3 areas: knowledge of diet, knowledge of exercise, and knowledge of risk factors, each with a score range of 0-26. The higher the score, the better the understanding of osteoporosis knowledge.

Quality of life: At discharge and 1 year after discharge, the MOS 36-item short-form health survey (SF-36) was used to assess their quality of life, which consists of 8 domains, including somatic function, physical function, somatic pain, general health, vitality, social function, emotional function, and mental health. The total score of quality of life was the sum of the scores of 8 domains, and the standardized scores were 0-100. The higher the score, the better the quality of life.

Nursing satisfaction: Nursing satisfaction was assessed using our homemade Satisfaction Questionnaire. This form has 20 questions, each with 5 points, with a total score of <70being dissatisfied, 70-89 being satisfied, and \ge 90 being highly satisfied.

Statistical analysis

The data of this study were organized and analyzed using SPSS version 22.0, and GraphPad Prism version 8 was chosen as the graphing software. Measurement data were expressed as mean \pm standard deviation ($\overline{x} \pm s$) and tested by *t* test. Count data were expressed as the number of cases (rate) and tested using a chi-square test. *P* < .05 indicates that the difference is statistically significant.

For treatment compliance, knowledge of osteoporosis, quality of life, and care satisfaction, we calculated the mean differences between the continuity group and the routine group and divided them by the pooled standard deviation to obtain Cohen's d values. The calculation formula for Cohen's d is as follows: d = (M1 - M2) / SD

Here, M1 represents the mean of the continuity group, M2 represents the mean of the routine group, and SD represents the pooled standard deviation of the two groups.

By calculating Cohen's d values, we can assess the effect sizes between the continuity group and the routine group. Larger Cohen's d values indicate a higher practical significance of the differences between the two groups, while smaller Cohen's d values may indicate a lower practical significance of the differences.

RESULTS

Patient characteristics

In the routine group, there were 24 males and 33 females, aged 61-82 (72.28 ± 5.42) years, with a duration of disease of 1-12 (7.33 ± 1.28) years. There were 29 patients with symptoms in the lower back, 13 in the extremities, and 15 in the lower back and extremities. In the continuity group, there were 26 males and 31 females, aged 62-83 (72.41 ± 5.39) years, with a duration of disease of 2-11 (7.42 ± 1.31) years. There were 28 patients with symptoms in the lower back in the lower back, 13 in the lower back, 13 in the duration of disease of 2-11 (7.42 ± 1.31) years.

Table 1. Patient characteristics $[x \pm s, n(\%)]$

	Routine	Continuity		
	group (n=57)	Group (n=57)	t/χ^2	P value
Sex			0.143	.706
Male	24	26		
Female	33	31		
Age (years)	61-82	62-83		
Mean age(years)	72.28±5.42	72.41±5.39	-0.128	.898
Duration of disease (years)	1-12	2-11		
Mean duration of disease (years)	7.33±1.28	7.42±1.31	-0.371	.711
Main symptom area			0.05	.823
Low back	29	28		
Extremities	13	13		
Low back and extremities	15	16		

Table 2. Treatment compliance [n(%)]

Crown		Complete	Good	Poor	Compliance (%)
Group	п	compnance	compnance	compnance	Compliance (70)
Routine group	57	21	24	12	78.9%(45/57)
Continuity Group	57	27	28	2	96.5%(55/57)
χ^2	-	-	-	-	8.142
P value	-	-	-	-	.004

Figure 1. Knowledge level of osteoporosis $(\overline{x \pm s})$



^a indicates P < .05.







Group	n	High satisfied	Satisfied	Dissatisfied	Satisfaction (%)
Routine group	57	13	34	10	82.5%(47/57)
Continuity Group	57	26	30	1	98.2%(56/57)
χ^2	-	-	-	-	8.15
P value	-	-	-	-	.004

extremities, and 16 in the lower back and extremities. The two groups showed similar baseline patient profiles (P > .05). (Table 1)

Treatment compliance

Among the patients in the routine group, 45 out of 57 patients achieved a compliance rate of 78.9%, including 21 cases of complete compliance, 24 cases of good compliance, and 12 cases of poor compliance. In comparison, the continuity group had a higher compliance rate of 96.5% (55 out of 57 patients), including 27 cases of complete compliance, 28 cases

of good compliance, and 2 cases of poor compliance. The continuity of care resulted in a significantly higher treatment compliance rate compared to routine care (P < .05). (Table 2)

Knowledge level of osteoporosis

In the routine group, the dietary knowledge scores at discharge and 1 year after discharge were $(4.38\pm1.06, 4.63\pm1.27)$, exercise knowledge scores were $(3.87\pm1.17, 4.18\pm1.63)$, and risk factor knowledge scores were $(4.95\pm0.97, 7.86\pm2.11)$. In the continuity group, the dietary knowledge scores at discharge and 1 year after discharge were $(4.41\pm1.05, 5.92\pm1.16)$, exercise knowledge scores were $(3.82\pm1.19, 5.28\pm1.66)$, and risk factor knowledge scores were $(5.03\pm1.02, 11.35\pm2.43)$. The difference in the degree of knowledge of diet, exercise, and risk factors by the time of discharge was of no statistical significance (P > .05). The continuity group had significantly higher levels of knowledge of diet, exercise, and risk factors 1 year after discharge than the routine group (P < .05). (Figure 1)

Quality of life

The SF-36 scores at discharge and 1 year after discharge were (43.41±6.32, 64.38±12.55) in the routine group and (43.35±6.27, 79.52±8.62) in the continuity group. There were no significant differences in SF-36 scores at discharge between the two groups (P > .05). However, continuity of care resulted in significantly higher SF-36 scores compared to routine care (P < .05). (Figure 2)

Nursing satisfaction

The nursing satisfaction of routine group patients was 82.5% (47/57), including 13 cases of highly satisfied, 34 cases of satisfied, and 10 cases of dissatisfied. The nursing satisfaction of patients in the continuity group was 98.2% (56/57), including 26 cases of highly satisfied, 30 cases of satisfied, and 1 case of dissatisfied. Patients with continuity of care had higher nursing satisfaction than those with routine care (P < .05). (Table 3)

DISCUSSION

Patients with osteoporosis usually suffer from movement restriction and pain, resulting in fear of social interaction and activities, which compromises their quality of life.¹³ Recovery from osteoporosis is a lengthy course that requires long-term medication, physical intervention, and functional exercise even after discharge from the hospital. However, most patients have reduced compliance with home treatment and decreased awareness of functional exercise.14 Continuity of care is an emerging model of care that has gradually developed in clinical practice in recent years, and the mobile health platform-based continuity of care is a new attempt based on continuity of care. The fundamental purpose of continuity of care is to facilitate a safe and smooth transition from hospital care to home care for patients. The mobile health platform enables rapid communication between doctors and patients, targeted guidance, and repeated learning and practice by patients.¹⁵ The merits of the mobile

health platform-based continuity of care used in the present study are as follows: (1) Common communication platforms such as WeChat and QQ were used to provide follow-up guidance on patients' health status and give regular health education; (2) Exclusive plans were customized for patients according to their recovery status, and patients were urged to develop good medication, exercise, diet, and lifestyle habits, and the patients were reminded to conduct regular reviews. The mobile health platform-based continuity of care further guided patients to attach importance to non-pharmacological treatments such as functional exercise and daily diet.¹⁶ Mobile health platform-based continuity of care interventions effectively enhance the quality of out-of-hospital care and compliance of patients with osteoporosis, positively contributing to patient outcomes and subsequent rehabilitation.¹⁷ A study¹⁸ applied mobile health platformbased continuity of care to patients with diabetes mellitus, malignant neoplastic diseases, and chronic heart failure and found that this model significantly lowered the rate of rehospitalization, improved the quality of life and cooperation of patients outside the hospital, and thus accelerated their recovery. Patient compliance with treatment after discharge from the hospital is an essential issue that affects the subsequent recovery of patients. The follow-up recovery process of osteoporosis patients requires at least 6 months, so a high degree of patient compliance in the first 6 months is considered of great importance to reduce the risk of rehospitalization, medical costs, and risk of disease disability.¹⁹

Here, continuity of care resulted in significantly higher treatment compliance and SF-36 scores versus routine care, indicating that mobile health platform-based continuity of care effectively enhances patients' compliance with treatment and quality of life after discharge, which may be attributed to the rapid communication and doctor supervision through the mobile health platform. With the rapid development of information technology in China, Internet platforms are available to achieve rapid and convenient communication. Healthcare providers can send relevant disease knowledge to specific groups through the voice, SMS, and video functions of cell phones, thus enhancing health education for patients, which plays a key role in the continuity of care. This model is time-sensitive, timely, continuous, and interactive, which compensates for the time or geographical limitations of previous telephone follow-up and home visits.²⁰ Herein, the continuity group's knowledge of diet, exercise, and risk factors was significantly higher than that of the routine group 1 year after discharge, which suggested mobile health platform-based continuity of care offers more disease awareness benefits for patients. Patient satisfaction is a major parameter to measure the quality of hospital medical services. A well-managed doctor-patient relationship can boost the motivation of medical staff and the compliance of patients.²¹ In the current study, patients with continuity of care showed higher nursing satisfaction than those with routine care, indicating a good clinical recognition of mobile health platform-based continuity of care by the patients and their families.

Overall, 1) the significantly higher levels of knowledge observed in the continuity group indicate that the continuity of care intervention had a lasting impact on patient education and knowledge retention. Enhanced knowledge empowers patients to make informed decisions about their lifestyle choices, such as following a proper diet, engaging in appropriate exercise, and avoiding risk factors. This increased awareness and understanding can lead to better self-management of osteoporosis, reduced risk of fractures, and improved longterm outcomes. 2) The higher SF-36 scores in the continuity group suggest a better quality of life for patients receiving continuous care. This improvement can be attributed to various factors, including enhanced symptom management, better physical functioning, reduced pain, improved mental well-being, and increased social support. A higher quality of life is not only important for the overall well-being of patients but also correlates with improved treatment outcomes, increased treatment adherence, and reduced healthcare utilization. 3) The significantly higher nursing satisfaction reported by patients in the continuity group indicates that the continuity of care intervention met patients' expectations and needs, fostering a positive patient-provider relationship. Increased nursing satisfaction suggests that patients felt supported, listened to, and actively involved in their care. This positive experience can lead to better patient engagement, improved treatment adherence, and a higher level of trust and confidence in the healthcare team. Ultimately, higher nursing satisfaction contributes to a patient-centered care approach, which is essential for achieving optimal health outcomes.

Implications

From a clinical practice perspective, these findings highlight the potential benefits of incorporating mobile health platforms into the care continuum for osteoporosis patients. Such platforms can provide ongoing support, education, and monitoring, which may contribute to better treatment adherence and increased patient knowledge about diet, exercise, and risk factors associated with osteoporosis.

In terms of public health implications, the study suggests that leveraging mobile health technologies in the management of chronic conditions like osteoporosis can have positive outcomes. By utilizing mobile health platforms, healthcare providers can extend their reach beyond hospital settings and provide continuous care and support to patients, potentially reducing the burden on healthcare systems and improving overall population health outcomes.

It is worth noting that, some potential adverse events or challenges that could arise during the implementation of a mobile health platform-based continuity of care intervention. 1) Technical issues: Challenges related to the functionality, reliability, or compatibility of the mobile health platform, such as system crashes, connectivity problems, or difficulties in accessing and using the platform. 2) Data security and privacy concerns: Adverse events related to the protection of patient data and privacy, including breaches in data security, unauthorized access to patient information, or inadequate encryption of sensitive

data. 3)User acceptance and engagement: Challenges in getting patients to adopt and actively engage with the mobile health platform, such as low user acceptance, resistance to technology, or difficulties in navigating and using the platform effectively. 4) Training and support: The need for comprehensive training and ongoing technical support for healthcare providers and patients to ensure proper utilization of the mobile health platform and address any issues or questions that may arise. 5) Integration with existing healthcare systems: Challenges in integrating the mobile health platform with existing healthcare systems, such as electronic health records (EHRs) or other information systems, to enable seamless data exchange and coordination of care. 6) Patient adherence and compliance: Difficulties in promoting patient adherence to the continuity of care intervention through the mobile health platform, including non-compliance with treatment plans, failure to regularly engage with the platform, or challenges in monitoring and tracking patient progress effectively.

Limitations

Here are some potential limitations that should be considered:

Selection bias: The study may have been subject to selection bias, as participants were assigned to either the routine or continuity group based on specific criteria. This could introduce potential differences between the two groups that may have influenced the outcomes. It is possible that patients who agreed to participate in the continuity of care intervention were more motivated or had different characteristics compared to those in the routine care group.

Generalizability: The study's findings may have limited generalizability due to factors such as the specific patient population, geographical location, or healthcare setting involved. The results may not apply to other populations or healthcare contexts, and caution should be exercised when extrapolating the findings to different settings. Single-center study: It may limit the generalizability of the findings to a broader population. Multi-center studies involving diverse healthcare settings and patient populations would provide more robust evidence.

CONCLUSION

Mobile health platform-based continuity of care effectively enhances post-discharge compliance and knowledge of osteoporosis in patients with osteoporosis, thereby improving post-discharge quality of life and satisfaction with care. In the future, studies with the following features are warranted. a. Long-term follow-up: Future research could explore the long-term effects of continuity of care interventions on treatment outcomes, knowledge retention, and quality of life. Extended follow-up periods would provide a more comprehensive understanding of the sustained benefits of continuity of care approaches in osteoporosis management. b. Cost-effectiveness analysis: Further studies could investigate the cost-effectiveness of continuity of care interventions in osteoporosis care. Evaluating the economic implications, including healthcare resource utilization, hospital admissions, and overall healthcare costs, would provide valuable insights for healthcare decision-makers and policymakers. c. Patient engagement strategies: Research could focus on identifying effective strategies to enhance patient engagement in continuity of care interventions. This may involve leveraging mobile health platforms, telehealth services, or personalized care plans to improve patient motivation, self-monitoring, and treatment adherence. d. Comparative studies: Comparative studies could be conducted to evaluate the effectiveness and feasibility of different continuity of care models or interventions, such as mobile health platforms, nurse-led programs, or multidisciplinary care teams. Comparing different approaches would help determine the most impactful and scalable strategies for implementing continuity of care in osteoporosis management.

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